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A cable pulling device that is suitable for use in the present invention is depicted in a side elevational view in Fig. [8] 9 and a cable engaging collet of the cable puller is depicted in Fig. [9] 10. The cable puller 120 is preferably formed with two parallelly disposed hydraulic pistons 510 having outer piston housings 512 that are mounted at their rearward ends 514 to a rear end fixture 516. A forward end fixture 528 is engaged to the forward ends of the outer housings 512. The hydraulic lines 132 are engaged to the end fixtures 516 and 528 through a suitable coupling 518 such that hydraulic fluid passes through the hydraulic lines 132, through the end fixtures 516 and 528 and into the two hydraulic pistons 510. Hydraulic push rods 524 project outwardly from the forward end fixture 528 and are fixedly engaged to a front end block 536. A slotted, generally cylindrical nose piece 540 is engaged to the front end block 536. The nose piece 540 is formed with a cable passage slot 544 cut through a side of the nose piece 540, and the outer diameter of the nose piece 540 is sized to mount within the shoulder 434 of the slotted annulus 124 of the frame member 84, as is described hereinbelow with the aid of Fig. 11. A generally U-shaped cable passage slot, generally denoted by the numeral 550 is formed in each of the front end block 536, forward end fixture 528 and the rear end fixture 514, such that the cable 70 can be installed within the cable pulling device 120 from its side. That is, it is not necessary to thread an end of the cable 70 through the cable pulling device 120.

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A further mole design 900 is depicted in Figs. 19, 20 and 21, wherein Fig. 19 is a side elevational view of the mole 900 depicted in a pipe bursting operation; Fig. 20 is a front elevational view of the mole 900 and Fig. 21 is a side elevational view of the mole 900 depicted in a further stage of a pipe bursting operation. As depicted in Fig. 19, the mole 900 is being pulled through a pipe 904 composed of fracturable material, such as cast iron or ceramic pipe. A pulling cable 70 is engaged to the mole 900 as has generally been described hereinabove. The mole 900 includes a tapered body portion 908 having a front end 912 whose diameter is less than the diameter of the pipe 904 and a rearward end [916] 914 whose diameter is greater than the diameter of the pipe 904. The tapered body 908 of the mole engages the pipe at a pipe engagement region 916 generally existing between the dotted pipe engagement lines 920, such

that a forward, intact section of pipe 924 exists in front of the engagement lines 920 and fractured pipe segments 928 exist behind the pipe engagement lines 920. It is therefore to be understood that a generalized outward force that is uniformly, circumferentially applied to the pipe 904 in the engagement region 916 causes the pipe material to fracture due to the large pulling force applied to the mole 900 through the cable 70. Therefore, in the mole embodiment 900 a smooth tapered surface mole is utilized to burst the fracturable pipe 904.

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A single blade 980 may be engaged within a blade holding slot 984 to project from the side of the tapered body portion 908. Significantly, the frontward edge 988 of the blade 980 is disposed rearwardly of the pipe fracturing region [716] 916, such that the blade 980 is not utilized in the pipe fracturing activity of the mole 900. The blade 980 is utilized where the mole 900 encounters pipe engagement fixtures such as the pipe flanges 990 which include a flexible seal 994. Specifically, as depicted in Fig. 21 and in comparison to Fig. 19, the mole 900 has been pulled (leftward) through the pipe 904 past the flange members 990, such that the pipe around the flange members has been fractured. Nevertheless, the flexible seal member 994 has remained intact. In testing with smooth tapered surface moles, the inventors have found that such moles work very well in fracturing pipe, however seals such as 994 sometimes create significant drag. Blade 980 thus augments the mole 900 by providing a sharp edge which will cut through the seal 994, whereby it will pass around the mole and not create a drag problem. It is therefore the case that a smooth tapered mole, without any fins is quite adequate to fracture and replace fracturable pipe such as cast iron and ceramic. Where certain types of pipe joinder fixtures are encountered, a blade 980 may be required to efficiently remove portions of the pipe engagement fixture from around the mole.

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Still further alternative mole designs are depicted in Figs. 22 and 23, wherein Fig. 22 is a side elevational view depicting an alternative fin design with a mole, and Fig. 23 is a side elevational view of the fin depicted in Fig. 22. As depicted in Fig. 22, a mole 1000 is formed with a tapered body portion [1001] 1004 having a front end 1008 whose diameter is less than the diameter of a pipe (not shown) through which the mole will be pulled, and a rearward end 1012

having a diameter that is larger than the diameter of the pipe. The mole 1000 is therefore
30 substantially similar to the mole 900 depicted in Figs. 19, 20 and 21. Specifically, a pipe
engagement region 1016 is generally defined as lying between two dotted pipe engagement lines
1020. The significant, novel features of the mole 1000 are found in the shape of a flange seal
splitting fin and the method of engagement of the fin to the mole body 1004.

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Returning to Fig. 22, the fin 1030 resides in a fin engagement slot 1060 formed in the
8 surface of the mole body 1004 such that the narrow frontward portion [1042] 1034 of the fin
resides completely within the slot 1060. The rearward portion 1064 of the slot 1060 is formed
10 with a corresponding approximately 80° angle, such that the rearward portion of the fin (defined
by angle A) is matingly engaged therein. The frontward end 1070 of the slot 1060 includes a
threaded bore 1074 for receiving a threaded screw 1078 having a tapered head 1082. The
frontward edge 1086 of the slot 1060 is tapered to receive the head 1082 of the screw 1078
therewithin, and the tapered frontward tip 1038 of the fin 1030 is matingly engaged by the head
1082 of the screw 1078. It is therefore to be understood that the fin 1030 resides in the slot 1060
such that the frontward tip 1038 is held in place by the head 1082 of the screw 1078 and the
rearward edge 1050 of the fin 1030 is held in place by the rearward end 1064 of the slot 1060
that has an angle A of approximately 80°. It will therefore be appreciated by those skilled in the
art that the fin 1030 can easily be removed entirely for general pipe fracturing operations, and
that the fin 1030 can be easily inserted should the need arise.

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An alternative method for the attachment of replacement pipe to the rearward end of a
22 mole is depicted in Figs. 25 and 26, wherein [Fig. 5] Fig. 25 is a side elevational view of the
replacement pipe attachment and [Fig. 6] Fig. 26 is a perspective view of the replacement pipe
attachment sleeve. As depicted in Figs. 25 and 26 a mole 1200 has a tapered smooth body 1204
25 having a relatively narrow frontward end 1208 and a relatively wide rearward end 1212. A
threaded, cylindrical sleeve engagement member 1216 is integrally formed with the mole body
1204 and projects rearwardly therefrom. As indicated hereabove, such a simple mole performs

quite adequately for fracturable pipe such as cast iron and ceramic materials. In fact, such a smooth mole will even split steel pipe due to the large pulling forces applied to it.

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As was previously described with regard to cable puller 120, and with reference to [Fig. 25] Fig. 28, when the hydraulic pistons 510 are activated the forward end fixture 528 moves away from the front end block 1412. The rearward motion of the forward end fixture 528 causes the collets 560 to close upon and grab the cable 70, pulling it rearwardly (to the right in Fig. 28). Significantly, the front collets 1408 do not grab the cable 70 during the rearward motion caused by the movement of the fixture 528. After the fixture 528 has completed its stroke of generally two to six inches, the forward end fixture 528 returns to its starting position and, the collets 560 release their hold upon the cable and slide forwardly along the surface of the cable. As has been indicated hereabove, where significant resistive force exists in the cable, the cable may stretch, whereupon the cable will not remain stationary, but rather it returns to its unstretched condition. It has been experienced that a long cable may actually stretch one to three inches, thereby significantly reducing the cable motion gain of each stroke of the cable puller.

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The front collets 1408 are thus provided to prevent the cable from returning to its unstretched position. Specifically, after a cable pulling stroke, and assuming that there is some cable stretching within the cable, upon release of the rearward collets 560, the cable will tend to move towards its unstretched position which would be leftward in Fig. 28. At this point the forward collets 1408 engage the cable and, due to the tapered surfaces 1416 of the collets 1408 and the collet engagement surfaces 1420 of the block 1412, the collets 1408 engage the cable and prevent its leftward motion, thereby retaining the tension in the cable. The frontward collets 1408 thereby prevent leftward cable motion and increase the efficiency of the cable pulling device by insuring that each cable pulling stroke will pull the cable a full stroke length, without significant cable return motion upon cable release by the pulling collets 560. While various collet designs are suitable, as depicted in Fig. 29, the preferred collet design includes two cable engagement members [560 and] 1408 that are rotatable about a collet engagement rod 1430, and which are pivotable about a rod engagement screw 1434. It is therefore to be understood that the

improved PTR cable pulling device 1400 provides for cyclic pulling of the cable 70 while it prevents any cable return motion between pulling strokes due to the use of the forward cable engaging collets 1408.